Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A11W0151

CONTROLLED FLIGHT INTO TERRAIN

AIR TINDI LTD.
CESSNA 208B CARAVAN, C-GATV
LUTSEL K'E, NORTHWEST TERRITORIES, 26 NM W
04 OCTOBER 2011

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

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Synopsis

The Air Tindi Ltd. Cessna 208B Caravan (registration C-GATV, serial number 208B0308) departed Yellowknife, Northwest Territories, at 1103 Mountain Daylight Time under visual flight rules as regularly scheduled flight Air Tindi 200 (AT200) to Lutsel K'e, Northwest Territories. When the aircraft did not arrive at its scheduled time, a search was initiated, and the aircraft was found 26 nautical miles west of Lutsel K'e, near the crest of Pehtei Peninsula. The pilot and one passenger were fatally injured, and two passengers were seriously injured. There was no post-impact fire, and no emergency locator transmitter signal was received by the Joint Rescue Coordination Centre or search aircraft.

Ce rapport est également disponible en français.

Other Factual Information

History of the Flight

After take-off from Yellowknife (CYZF), a direct track to Lutsel K'e (CYLK) was established with slight variations in groundspeed and track (see Appendix A). Altitude varied between 850 feet and 1470 feet above sea level (asl). Aircraft height above ground level (agl) varied between 129 feet and 600 feet. One minute before its impact with the west side of Pehtei Peninsula, the aircraft was at 1325 feet asl, or 500 feet agl, 136 knots ground speed, and tracking 091° true (T). Immediately before impact, altitude 1060 feet asl, the ground speed was 141 knots, and track was 098°T.

C-GATV was equipped with a SkyTrac global positioning system (GPS)based flight-following system. The system transmits information including aircraft position, altitude, groundspeed, and track via satellite link to the company at subscribed 15-minute intervals. The on-board equipment recorded this data at 5-second intervals. The 5-second interval data was extracted by the TSB laboratory and was used to reconstruct the accident flight. The last SkyTrac transmission at 1140 [1] showed the aircraft at rest, indicating the time of the accident.

The aircraft GPS unit contained no useful data.

Accident Site

The terrain between Yellowknife and Lutsel K'e consists of gently rolling, tree-covered Canadian Shield rocky outcrops, with interspersed lakes. Ground elevation on the route varied from 600 feet to 1100 feet asl. The accident site, on Pehtei Peninsula, was near the highest point on the route, rising about 500 feet from the surface of Great Slave Lake (Appendix B). The peninsula is oriented nearly perpendicular to the aircraft's flight path to Lutsel K'e.

The first point of impact was at an elevation of 1013 feet asl, 38 feet below the top of the peninsula, and 20 feet above the face of a vertical cliff. As indicated by light wing strikes on tree-tops and ground scars, the aircraft was in a nearly level attitude in pitch and roll. First ground impact was by the landing gear, followed by the belly cargo pod and the propeller, all of which separated from the aircraft at this point. The aircraft continued up a 10° slope over the top of the hill, became airborne, and came to rest inverted 477 feet down the eastern slope of the peninsula. The cockpit was crushed, and the forward passenger cabin was distorted, with the forward cabin bulkhead mostly dislodged from its attachments. The left wing had folded back, and rested on the ceiling of the cabin.

Search and Rescue

The last radio call heard from C-GATV was a position report indicating the distance of 20 miles from Lutsel K'e, and did not include other usual information such as arrival intentions and estimated time of arrival. This call was heard by the crew of another aircraft that was also

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1 All times are Mountain Daylight Time (Coordinated Universal Time minus 6 hours).

inbound to Lutsel K'e from Yellowknife. When the flight failed to arrive at its scheduled time of 1145, the Air Tindi representative at Lutsel K'e alerted the company at 1223. The last known position appearing on the Air Tindi headquarters SkyTrac database indicated that C-GATV had stopped short of Lutsel K'e, and the company emergency response plan was activated at 1245. Two company fixed wing aircraft were dispatched on visual and electronic searches. A rescue crew in a float-equipped de Havilland DHC-6 located the wreckage at 1420, and landed on nearby Great Slave Lake. The crew hiked into the accident site and arrived at 1530. The survivors were shuttled by helicopter to the float plane, and evacuated to Yellowknife at 1800.

Meteorological Conditions

The Graphical Area Forecast (GFA) valid from 0600 to 1200 indicated that the region was under the influence of a trough of warm air aloft. The system featured overcast layers from 2000 to 4000 feet asl with tops at 24 000 feet asl, and scattered altocumulus castellanus topped at 22 000 feet asl. Predicted localized visibilities were from 3 to more than 6 statute miles (sm) in light rain showers and mist, and patchy ceilings were from 800 to 1500 feet agl. Moderate mixed icing was predicted above the freezing level (5000 feet asl).

The terminal forecast for Yellowknife, issued at 0538, was valid for the period from 0600 on 04 October until 0600 on 05 October and was available to the pilot before departure. For the period of the flight, the weather was forecast to be wind 120°T at 12 knots; visibility more than 6 sm in light rain; sky condition few at 600 feet agl, broken at 1500 feet agl. Temporarily, the visibility was to be 3 sm in light rain and mist, with clouds broken at 600 feet agl. A revised forecast, issued at 1102, predicted essentially the same conditions, with a temporary lower broken cloud height of 500 feet agl.

The 1100 aviation routine weather report (METAR) for Yellowknife reported wind 110°T at 12 knots gusting to 18 knots; visibility 3 sm in light rain and mist; sky condition 500 feet agl broken, 1000 feet agl overcast; temperature 6°C, dewpoint 5°C; altimeter 29.66 inches of mercury (in. Hg); remarks cloud cover stratocumulus 6 eighths, stratocumulus 2 eighths.

The 1200 METAR for Lutsel K'e reported wind 120°T at 5 knots; visibility 10 sm in rain showers; sky condition 1000 feet agl scattered, 1500 feet agl overcast; temperature 6°C, dewpoint 5°C; altimeter 29.75 in. Hg; remarks stratus 4 eighths, stratocumulus 4 eighths. The 1200 weather featured a slight improvement since the last observation at 1000. The 1100 observation was missing. A pilot report for Lutsel K 'e at 1200 indicated visibility greater than 6 sm, a ragged ceiling between 1000 and 1200 feet asl, with rain showers in the vicinity. There was no reported icing in the area at 5000 feet asl and below.

When C-GATV departed Yellowknife under a visual flight rules (VFR) clearance, the visibility was at the VFR minimums of 3 sm. VFR operations within the control zone were allowed without requiring a special VFR clearance. [2] Once en route, clear of the Yellowknife control zone and below 1000 feet agl, the aircraft was required under Canadian Aviation Regulations (CARs) subpart 602.115 to remain clear of cloud with flight visibility not less than 2 sm. The flight was

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[2] Under Canadian Aviation Regulation (CAR) subpart 602.117, traffic permitting, fixed-wing aircraft may be authorized to operate in a control zone under special VFR at visibilities between 3 sm and 1 sm, provided they remain clear of cloud.

conducted on a direct track at low level, below a low ragged cloud base. In the last minutes of the flight, it was reported that visibility had become reduced.

Route Information

Lutsel K'e is located 106 nautical miles (nm) east of Yellowknife on a bearing of 091°T. The company operations manual contained a published route with a minimum instrument flight rules (IFR) altitude of 3100 feet asl. This provided a minimum of 2000 feet of terrain clearance from the highest elevation of 1100 feet, which was in the vicinity of the accident site. Most of the route lay in uncontrolled airspace, and an ATC clearance was not required. CYLK was served by an instrument approach, RNAV (GNSS) [3] RWY 08T, with a minimum straight-in LNAV [4] descent altitude of 1160 feet asl, or 567 feet agl.

Yellowknife airport was served by 1 precision approach, and 4 non-precision approaches. With 1 useable precision approach, the weather minimums for use of Yellowknife as an IFR alternate were ceiling 600 feet agl and visibility 2 sm. [5] Given the forecast weather available to the pilot before departure, Yellowknife was usable as an IFR alternate.

Operational Control

Air Tindi Ltd. is based at Yellowknife and operates a fixed-wing fleet under Transport Canada CAR subparts 705, 704, 703 and 702. Cessna 208B scheduled air service to surrounding communities is conducted under CAR subpart 703. The company is authorized under Operation Specification Number 1 to operate single-engine aircraft for transportation of passengers under IFR and day and night VFR.

The company operates under a pilot self-dispatch system under which the operations manager, who is responsible for day-to-day conduct of flight operations, delegates operational control of flights to the pilot-in-command. At the time of the occurrence, crews, were afforded latitude to conduct scheduled passenger operations under VFR. The pilot-in-command is responsible for ensuring that appropriate documents are prepared and filed prior to departure, which includes filing of an operational flight plan. A NAV CANADA flight plan, company flight itinerary, or company operational flight plan had not been filed on the accident flight in accordance with the company operations manual (COM) requirements. Consequently, when the flight was reported missing, there was some confusion in dispatch regarding which aircraft had been used as dispatch had assigned a different aircraft for the occurrence flight.

The offices of all company operational managers were situated at the Yellowknife float base 3 nm from the airport from which the company's dispatch and wheeled aircraft operated. Although permitted by the CARs, and consistent with industry practice, this separation reduced management's ability to supervise these operations directly.

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3 Instrument approach based on area navigation (RNAV) using a global navigation satellite system (GNSS)

4 Lateral navigation

5 Alternate weather requirements as stated in NAV CANADA's *Canada Air Pilot* are based on instrument approach and weather forecast availability.

As an operator under CAR subpart 705, Air Tindi was required by CAR subpart 107.01 to implement a safety management system (SMS). In addition, Air Tindi extended its SMS to include its CAR subpart 702, 703, and 704 operations. The company chose to comply with the CAR SMS requirements through a phased implementation plan. After remedial action in response to a September 2009 review by Transport Canada, Air Tindi's SMS was assessed as satisfactory in January 2011.

Following this assessment, the company made certain management changes and alterations to the program. A process validation inspection [6] in March of 2011 and a follow-up inspection in January 2012 resulted in a number of findings which required further work on the company's corrective action plan (CAP). At time of writing, Transport Canada had accepted the CAP; however, the company had not completed full implementation.

Pilot

Air Tindi employed a pilot-in waiting program in which newly licensed pilots would work as ramp attendants for a period of time before moving into a pilot position. The pilots would gain operations experience and knowledge in the industry, and the company would benefit from assessing the suitability of prospective pilots. Initially, they would fly as co-pilots on multi-engine aircraft and be mentored by experienced pilots. This was followed by type training on the Cessna 185 or Cessna 208 for day VFR operations and line indoctrination to scheduled service destinations.

The accident pilot progressed through this program after obtaining a commercial pilot license - aeroplane in 2004. He worked as a ramp attendant until 2007 and then began flying as a co-pilot on the de Havilland DHC-6, acquiring approximately 1500 hours, primarily in VFR operations. In 2010, he began flying as co-pilot on the Beech King Air 200, on which he acquired approximately 450 hours of IFR flying. In February 2011, he began training on the Cessna 208, completing a VFR pilot proficiency check ride in March 2011, followed by company line indoctrination on type. He did not pass a renewal Group 3 (single-engine) IFR check-ride due to difficulties with GPS use, but after additional training, he passed a second IFR check-ride on 18 August 2011. All the pilot's revenue flights in the C208 as captain were under VFR. The pilot was qualified for the flight, and had a valid instrument rating as well as medical and pilot proficiency certification. The pilot's flight and duty time limits were not exceeded. The pilot had just returned to work after 3 days off, and there were no indications that fatigue affected the pilot's performance.

Toxicology

Post-mortem toxicological screening revealed the presence of cannabinoids in the pilot's system. Femoral blood contained 50.1 nanograms per millilitre (ng/ml) of delta^9-tetrahydrocannabinol (delta^9-THC), and 21.6 ng/ml of carboxy-THC. Pleural fluid contained 11.9 ng/ml of delta^9-THC, as well as 41.8 ng/ml of carboxy-THC. Urine contained 272 ng/ml of carboxy-THC. Considering the significant amount of THC in the pilot's blood, the TSB considered

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[6] A process comprised of a documentation review and an on-site review of one or more components of a safety management system (SMS) or other regulated areas of an enterprise

confirmation by retesting. The small quantity of remaining femoral blood sample precluded retesting.

Cannabinoids

Cannabinoid Physiology

Delta^9-THC is the principal psychoactive cannabinoid found in marijuana, hashish, hash oil, and certain hemp products. Delta^9-THC is metabolized in the liver, with the formation of psychoactive and inactive compounds. Carboxy-THC is an inactive metabolite. THC compounds are stored in fatty tissue, reaching peak concentrations in 4 to 5 days. [7] Metabolic products are eventually excreted and total elimination of a single dose may take up to 30 days. [8]

Recency

A number of factors complicate accurate determination of the recency of cannabinoid use. These include the mode of intake (smoking versus eating), concentration of cannabinoids, and individual variations. [9] Delta^9-THC blood plasma concentrations in live subjects over 2 to 3 ng/ml have been shown to indicate marijuana smoking within 6 hours. [10] Dispersal and redistribution of cannabinoids occurring in the post-mortem interval before sampling for toxicological analysis can alter the presence of cannabinoids in tissues and fluids. This increases the difficulty in the application of formulae to establish accurate usage time-frames. [11,12]

Effects of THC

Flight simulator experiments have demonstrated that THC has wide ranging effects on human performance, including impairment of working memory, coordination, tracking, perceptual-motor performance, temporal perception, and vigilance. The effects of impairment increase with the complexity of the task. [13] A blood delta^9-THC concentration over 5 ng/ml is the threshold

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7 C. Heather Ashton, "Pharmacology and effects of cannabis: a brief review," *British Journal of Psychiatry* (2001), 178, pp. 101–106

8 M. Maykut, "Health consequences of acute and chronic marijuana use," *Progress in Neuropsychopharmacology and Biological Psychiatry*, (1985), pp. 209–238.

9 Vern Davis, "Guidelines for the accident investigator in the interpretation of positive THC (Cannabinoids) results", produced for the Transportation Safety Board of Canada, 2001.

10 M. Huestis et al, "Blood Cannabinoids. I. Absorption of THC and formation of 11-oh-THC and THCCOOH during and after smoking marijuana," *Journal of Analytical Toxicology*, Vol 16, (Sept/Oct 1992), pp. 276–282.

11 N.P. Lemos, Eric A. Ingle, "Cannabinoids in postmortem toxicology", *Journal of Analytical Toxicology*, Vol 35 (September 2011) pp. 394–401.

12 M. Huestis et al, "Blood Cannabinoids. II. Models for the prediction of time of marijuana exposure from plasma concentrations of delta^9–tetrahydrocannabinol (THC) and 11-nor-9-carboxy-delta 9-tetrahydrocannabinal (THCCOOH)," *Journal of Analytical Toxicology*, Vol 16, (Sept/Oct 1992), pp. 283–290.

13 J. Yesavage, V. Leirer, M. Denari, L. Hollister, "Carry-over effects of marihuana intoxication on aircraft pilot performance: a preliminary report," *American Journal of Psychiatry*, (Nov 1985), 142:11, pp. 1325–1329.

considered to be necessary for possible impairment. Even allowing for a reasonable margin of error in the toxicology results, the amount of THC present in this occurrence is considerably greater than the threshold that resulted in degraded pilot performance in studies on the impairing effects of THC. [14]

Studies have established the relative risk of road accidents involving cannabis-impaired versus sober drivers as "odds ratios". A blood delta^9-THC concentration of 6 to 8 ng/ml correlated with a blood alcohol level of .05%, and an odds ratio of 1.5 to 2 times the risk of accident for a sober person. Drivers who were under the influence of cannabis tended to compensate consciously by operating more cautiously. [15]

The duration of THC effects is variable, subject to a number of conditions. Generally, after a single dose of marijuana, there will be some impairment for up to 6 hours. Experiments have suggested significant carry-over impairment in complex human/machine performance such as flying, up to 24 hours after a moderate dose of THC via inhalation. This influence can occur after an individual ceases to be aware of any influence of the drug. [16]

Previous Occurrences Involving Cannabinoids

Since 1991, the TSB has documented 4 occurrences [17] in air, marine and rail modes where those involved in the operation of vehicles have either tested positive for cannabinoids, or were known to have used the substance while in a position of responsibility for those vehicles. Although some clients of aviation operators in Canada require pre-employment and periodic drug and alcohol screening, there are no Canadian regulations requiring persons employed in federally regulated transportation industries to submit to toxicological testing. United States federal transportation law requires drug and alcohol testing of all employees in safety-sensitive transportation positions, including aviation. [18]

Previous Flight

Earlier on the morning of the accident, the pilot flew C-GATV on a regularly scheduled flight at 0800, from Fort Simpson, Northwest Territories, (CYFS) to Yellowknife as flight AT222, arriving at 0919. The flight was conducted on a NAV CANADA VFR flight plan on a direct routing, which placed it on airway V339. The Fort Simpson Community Aerodrome Radio Station reported the 0800 weather as visibility 6 sm in light rain and mist; clouds 300 feet agl broken, 1500 feet agl overcast. Shortly after take-off, the aircraft entered cloud, and for most of the flight the aircraft cruised in cloud at about 3900 feet asl. For much of the trip, this was above the floor of controlled airspace at 2200 feet agl in which an IFR clearance was required.

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14 D.Moody, K. Monti, D. Crouch, "Analysis of forensic specimens for cannabinoids," *Journal of Analytical Toxicology*, Vol. 116, (Oct 1992), pp. 302–306

15 F. Grotenhermen et al, "Developing limits for driving under cannabis," *Journal Compilation Society for the Study of Addiction,* (2007).

16 V. Leirer, J. Yesavage, D. Morrow, "Marijuana carry-over effects on aircraft pilot performance," *Aviation, Space & Environmental Medicine* (1991), 62:221-7.

17 TSB investigation reports M91W1057, A01C0236, M06W0052, R10V0038.

18 United States Department of Transportation (DOT) rule 49 CFR Part 40

Fuel

C-GATV departed Yellowknife for Lutsel K'e with an estimated 760 pounds of fuel, which would have been sufficient for the aircraft to fly the trip under VFR, but not under IFR. Air Tindi employed ramp attendants to assist with flight dispatch, including re-fuelling, and sufficient time existed between the arrival from Fort Simpson and the scheduled departure for Lutsel K'e to load the necessary IFR fuel. Passenger and cargo load did not limit the possibility of loading fuel adequate for IFR reserves.

Over-water Operations

The glide distance chart in the *Cessna 208B Pilot's Operating Handbook* indicates that at 1000 feet agl, the glide range is 2 nm with cargo pod installed. From 500 feet agl, the glide range is 1 nm. On the direct track to Lutsel K'e flown by C-GATV, the aircraft would have to cross 11 nm of open water from a point less than 1 nm east of the accident site (Appendix A). In the event of engine failure at 1000 feet agl, the aircraft would have been beyond gliding distance of land for the 7 nm in the middle of the crossing. CAR 602.62 requires that no aircraft shall operate over water beyond a point where it cannot reach shore in the event of an engine failure unless personal floatation devices are carried for all occupants. The Air Tindi single-engine land aircraft did not carry personal floatation devices. The company operations manual required pilots to abide by all CARs, including the requirement to remain within gliding distance of land.

Local pilots of single-engine aircraft en route at low level from Yellowknife to Lutsel K'e commonly reduced their exposure to overwater flight by diverting about 10 nm to the south in order to remain near land. To execute this diversion from the point of the accident, the pilot would be required to make more than a 90-degree turn to the right and backtrack to the southwest.

On the previous flight, AT222, the aircraft crossed 9 nm of open water over the North Arm of Great Slave Lake. At the midpoint of the crossing, the aircraft at 1000 feet agl and with a gliding distance of 2 nm was beyond gliding distance of land in the event of an engine failure.

Aircraft

C-GATV was a single-engine, turbine-powered Cessna 208B with a normal configuration of 9 passenger-cabin seats. For the accident flight, 2 seats had been removed for cargo, leaving 7 passenger seats. The aeroplane was equipped for IFR operations, and included a GPS receiver with no terrain awareness features. Records indicate that the aeroplane was certified, equipped, and maintained in accordance with existing regulations and approved procedures. It had no known deficiencies before the first flight of the day, and at the time of the occurrence the aircraft weight and balance was within prescribed limits. There was no indication of pre-impact structural failure or failure of flight control systems. Damage to the propeller and engine indicated that the engine was developing power, and that immediately before impact high engine power had been applied.

Emergency Locator Transmitter

C-GATV was equipped with a Kannad 406 AF- COMPACT emergency locator transmitter (ELT), part number S184-0501-04, serial number 26214830036. The ELT was connected by cable to an external roof-mounted antenna and to a remote cockpit switch. During field examination

of the wreckage, the ELT was noted to be out of its mounting tray and hanging by the antenna cable. The remote control panel wires were broken near the plug on the ELT. The antenna had been broken off by ground contact, and its cable was continuous from the antenna base to the ELT. Due to loss of the antenna, no 406 MHz signal was recorded by the Joint Rescue Coordination Centre (JRCC), nor was a 121.5 MHz signal received by search and rescue aircraft. When rescuers arrived on site, they noted that the ELT was operating, as evidenced by an indicator light and audio. During shop testing following the accident, the unit was shown to be capable of producing effective signals.

The ELT had been mounted in the aircraft on the upper right hand–side wall of the tail section, immediately behind the cargo bay. The mounting system consists of a rectangular composite tray affixed to the aircraft. The ELT rests within a raised box structure around the perimeter of the mounting tray, and is secured by a fabric strap featuring a hook and loop (Velcro) system. When the strap is tight, the ELT is firmly held in the mounting tray box (Photo 1).

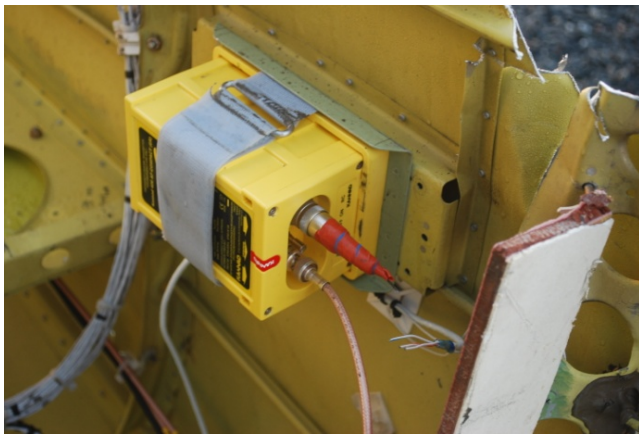


Photo 1. Mounted ELT in C-GATV

Photo 2. ELT sliding under loose strap

Field examination of the ELT and mounting bracket in C-GATV revealed that the retention strap was loosely fastened and that it was possible to slide the ELT under the strap and back into its mount (Photo 2). The unit could easily be removed in the same manner. After adjusting the strap by shortening it ¾ inch, the strap was tight around the ELT, which was then firmly secured in the bracket. The ELT then could not be manually removed without loosening the strap.

Instructions in the installation manual,[19] directed installers to align the strap buckle with the centre line of the unit, and to "Fasten the self-stripping strap tightly." There was no further definition of the degree of strap tightness required to adequately retain the ELT in the mounting tray.

[19] Kannad Installation Operation Manual, Revision 3, 05 May 2010, pp. 204–205

Controlled Flight into Terrain

The Flight Safety Foundation defines a controlled flight into terrain (CFIT) accident as "one in which an airworthy aircraft, under the control of the crew, is flown unintentionally into terrain, obstacles, or water with no prior awareness on the part of the crew of the impending collision." Some of the factors that may contribute to CFIT are:

- single-pilot operation;
- VFR into instrument meteorological conditions (IMC);
- misidentification of significant terrain along the route;
- no terrain-avoidance instrumentation.

This type of accident often occurs when visibility is low, at night, or during poor weather. Such conditions reduce a pilot's situational awareness of surroundings and make it difficult to tell whether the aircraft is too close to the ground. The risk is even greater for small aircraft, which venture further into remote wilderness or into mountainous terrain but are not required to have the same ground proximity warning equipment as large airliners.

From 2000 to 2009, there were 129 CFIT accidents in Canada. These accidents accounted for 5% of accidents and 25% of all fatalities. For air taxi operators (CAR subpart 703) during the same 10-year period, CFIT accidents accounted for 7% of total accidents, and 35% of fatalities.

In March 2010 and again in June 2012, the TSB released its Watchlist identifying the safety issues investigated by the TSB that pose the greatest risk to Canadians. In each case, actions taken to date are inadequate and concrete steps must be taken on the part of industry and the regulator to eliminate these risks. One of the safety issues on the Watchlist involves CFIT accidents, and the Board's concern is that until more steps are taken, the risk will persist.

Terrain Awareness and Warning System

The regulatory change required to substantially reduce or eliminate the safety deficiency was described in Recommendation A95-10, which recommended that "The Department of Transport require the installation of ground proximity warning systems (GPWS) on all turbine-powered IFR-approved commuter and airline aircraft capable of carrying 10 or more passengers."

Since that recommendation was made, advances in technology have resulted in cockpit equipment that can significantly improve a pilot's situational awareness. Some of this technology is now cost-effective for small aircraft.

An effective, last line of defence against CFIT accidents is terrain awareness and warning systems (TAWS). These systems provide aural and visual alerts to flight crews when the path of the aircraft is predicted to collide with terrain, water or obstacles, allowing the flight crew sufficient time to take evasive action. No TAWS was installed in C-GATV, and at the time of the occurrence, it was not required by Transport Canada regulations.

On 04 July 2012, TC issued regulations under CARs 605.42, 703.71, 704.71 and 705.85 requiring private and commercial turbine-powered aircraft configured with 6 or more passenger seats

and operating under IFR and/or night VFR to be equipped with, and operate, TAWS. Newly manufactured aircraft must be equipped with TAWS immediately, and 2 years after the date of promulgation, this regulation will apply to all similarly configured aircraft manufactured prior to promulgation.

As a result of these actions, the response to recommendation A95-10 was assessed by the TSB as Fully Satisfactory.

CFIT Training

In accordance with the TC Commercial Air Service Standard (CASS) 723.98(29), air operators which operate under IFR or night VFR are required to provide flight crews with CFIT avoidance training. Air Tindi had contracted out for Web-based initial and recurrent CFIT training. The accident pilot completed this training on 17 September 2009, and was due for biennial recurrent training on 01 October 2011; on the day of the accident, this training was 4 days overdue. A computer system employed by the company to track pilot training requirements had correctly identified that the pilot was due for recurrent training on 01 October 2011; however, the alerting system had been set to flag this training every 3 years instead of 2 years.

The following TSB Laboratory report was completed:

LP LP130/2011 - Non Volatile Memory and Instrument Analysis

Analysis

When C-GATV departed for Lutsel K'e, the weather at Yellowknife was marginal for VFR flight. Low cloud persisted for the entire flight, which was flown at low level so the pilot could maintain visual contact with the ground. The descent during the last 2 minutes of the flight suggests that the ceiling had become lower.

The conduct of the flight and the nature of the impact were characteristic of a CFIT event: the aircraft struck rising terrain under the pilot's control at cruise speed, with a wings-level attitude and a heading generally consistent with the direct track to the destination. Because no effective evasive manoeuvres were made before impact, it is likely that the crest of the Pehtei Peninsula was obscured in fog, and not visible to the pilot. The application of increased engine power immediately before impact was likely made when the terrain in front of the aircraft suddenly became visible.

When the pilot transmitted a position report 6 nm closer to Lutsel K'e than the actual position, it is possible that he believed that the shoreline of Great Slave Lake had been crossed and that open water at about 500 feet asl lay ahead. Since GPS was likely the primary navigational aide, there should have been little ambiguity in position, unless the unit was set to a waypoint associated with the RNAV approach at Lutsel K'e. However, the location of the site and the wreckage trail track indicate that the aircraft was proceeding directly to the airport. If an instrument approach had been planned, the aircraft should have been navigating toward a waypoint associated with the approach, and at an altitude no lower than 3100 feet, in accordance with the company-published route.

A TAWS installation in C-GATV could have warned of the impending collision with the ground, possibly in sufficient time to prevent the accident.

VFR Flight in Marginal Weather

It could not be determined why the pilot chose to fly the trip under VFR. Conditions were suitable to enable operation under IFR at altitudes providing safe terrain clearance. The pilot, the aircraft and the company were qualified to operate the trip under IFR. The en route weather was suitable, and with the freezing level well above the minimum IFR route altitude, icing was not a factor to preclude IFR flight. The cloud base was above the minimums required for successful completion of an approach and landing at Lutsel K'e. Before departure, the forecast weather was such that Yellowknife could be filed as an IFR alternate.

The fuel load was not considered to be a factor in the pilot's decision to fly the trip under VFR rather than IFR. Fuel was readily available at Yellowknife, and there was adequate time between the arrival from Fort Simpson and the departure for Lutsel K'e to bring the fuel quantity to IFR requirements under the supervision of dispatch personnel.

Although the pilot had gained experience in an IFR environment during his flying as a co-pilot in multi-engine aircraft, he had limited experience in single-pilot IFR operations. This may have led to reluctance to file an IFR flight plan on the accident flight, and the decision to remain visual in marginal VFR weather conditions. The route lay mostly in uncontrolled airspace, and when flight visibility deteriorated, the pilot had the option of climbing without ATC clearance to a safe altitude, and conducting an instrument approach at Lutsel K'e. The pilot apparently

was willing to fly in cloud as indicated by the earlier flight from Fort Simpson to Yellowknife, albeit on a VFR flight plan in controlled airspace.

Pilot Decision-making and THC Effects

On the day of the accident, aspects of the pilot's planning, flying technique and decision-making were inconsistent with regulatory and administrative requirements, the company operations manual policy, and safe flying practices. These included VFR flight in marginal visual weather conditions, flight in IMC on a VFR flight plan, and overwater flight beyond gliding distance of land. The quantity of psychoactive components in the pilot's system is considered to have been sufficient to have resulted in impairment of cognitive processes. This would likely have had an effect on planning and conduct of the accident flight. It is possible that the pilot, under the influence of cannabis, avoided the higher workload of IFR flight in IMC, choosing to remain visual for the trip to Lutsel K'e. Random testing of employees in safety sensitive positions may mitigate this risk.

Overwater Flight Risk

The company did not provide personal floatation devices in the land-plane fleet, and management expected single-engine aircraft to remain within gliding distance of land at all times. The pilot was familiar with the route, and given the low cloud en route and the current weather at Lutsel K'e, it is likely that a diversion to the south to remain within gliding distance of land would have to be made well before arriving at the shoreline near the accident location. The direct flight track flown toward Lutsel K'e suggests that, after crossing the Pehtei Peninsula, the pilot was prepared to overfly 11 nm of open water at low level, increasing the risk to the aircraft and its occupants. Over-flight of Great Slave Lake on the earlier flight from Fort Simpson to Yellowknife indicated a willingness on the part of the pilot to accept that risk.

ELT

Due to a loosely fastened hook and loop retention strap on the ELT installation, the ELT was ejected from its mounting tray during the impact. Since instructions do not describe a method for determining the required degree of tightness to retain the ELT in its mount, the installer's own judgement is relied upon to determine this. As a result, a wide variation in the quality of installation of ELTs that are retained by this method could increase the possibility of inadequate retention. In this accident, in the absence of a transmitted 406 MHz signal, the on-board GPS-based flight-following equipment (SkyTrac) was effective in directing the search party to the accident site and reduced the time for the search and rescue of the survivors.

Findings

Findings as to Causes and Contributing Factors

1. The aircraft was flown at low altitude into an area of low forward visibility during a day VFR flight, which prevented the pilot from seeing and avoiding terrain.

2. The concentrations of cannabinoids were sufficient to have caused impairment in pilot performance and decision-making on the accident flight.

Findings as to Risk

1. Installation instructions for the ELT did not provide a means of determining the necessary degree of strap tightness to prevent the ELT from being ejected from its mount during an accident. Resultant damages to the ELT and antenna connections could preclude transmission of an effective signal, affecting search and rescue of the aircraft and occupants.

2. Flying beyond gliding distance of land without personal floatation devices on board exposes the occupants to hypothermia and/or drowning in the event of a ditching.

Other Findings

1. Earlier on the day of the accident, the pilot flew the route from Fort Simpson to Yellowknife in cloud on a visual flight rules flight plan in controlled airspace.

2. With the ELT unable to transmit a useable signal, the SkyTrac system in C-GATV was instrumental in locating the accident site. This reduced the search time, and allowed for timely rescue of the seriously injured survivors.

Safety Action

Safety Action Taken

Transportation Safety Board of Canada

The TSB promulgated *Safety Advisory 825-A11W0151-D1-A1, Loose Attachment of Kannad 406 AF-Compact (ER) ELT*, dated 19 April 2012. This advisory indicated that Transport Canada may wish to inform owners, operators and maintainers of aircraft with ELTs featuring fabric hook and loop retention systems of the necessity to ensure adequate retention of the ELT in the event of an accident.

A similar safety advisory, *825-A11W0151-D1-A2*, was addressed on 19 April 2012 to ELT manufacturers utilizing fabric loop and hook retention systems, advising that they may wish to develop and publish methods of determining the degree of strap tightness, and to inform maintenance personnel of the necessity of proper installation.

U.S. Federal Aviation Administration

The U.S. Federal Aviation Administration (FAA) issued Special Airworthiness Information Bulletin HQ-12-32, dated 23 May 2012, addressed to ELT manufacturers, installers and aircraft maintenance personnel. The Bulletin expressed a concern with ability of hook and loop style fasteners to retain their designed capability to restrain ELTs during accident impact, and with the quality of installation instructions to ensure adequate tightness of the fasteners.

Air Tindi Ltd.

The company issued a company directive, dated 07 October 2011, which initiated the following policies for scheduled services operations:

Dispatch limitations:

- All scheduled flights will be dispatched under IFR. VFR flight may only be conducted if authorized by operations management personnel.
- No company aircraft may be operated on any scheduled passenger flight when the observed weather is at, or forecast to be lower than, the alternate minima for the destination airport.

Air Tindi instituted changes to the operational control system of scheduled passenger flights to ensure adequate flight following and timely reporting of departure and arrival times to the company System Operations Control Centre (SOCC).

In order to facilitate incident and accident investigations, Air Tindi has commenced installation of Appareo Vision 1000 Systems cockpit imaging and flight data monitoring devices in the Cessna 208B fleet.

In order to improve operational oversight, the company has consolidated most management personnel at the airport base.

The company has revised the existing drug and alcohol policy to include random testing of employees in safety-sensitive positions. These positions include pilots, maintenance engineers and dispatch personnel.

Kannad Aviation

Kannad Aviation (Orolia Group) has developed a new type of ELT called Integra, which has received European Aviation Safety Agency (EASA), FAA and Transport/Industry Canada certification. The ELT is equipped with an internal integral antenna. When circuits detect a low standing wave ratio due to a lost connection with the external antenna, as in this occurrence, the ELT automatically switches to the internal antenna. To enhance accuracy in position detection, the Integra ELT is also equipped with an internal GPS antenna and receiver.

On 12 June 2012, Kannad Aviation (Orolia Group) issued Service Bulletin S1800000-25-04 that outlines the instructions for properly securing the ELT during installation and reinstallation and the instructions for inspecting fasteners of mounting brackets; it also defines the replacement interval for the mounting bracket fasteners.

On 11 February 2013, Kannad Aviation issued Service Bulletin SB1840501-25-25-05 Rev01, entitled Kannad 406 AF-Compact, Kannad 406 AF-Compact (ER) Integra ELTs Family - Guidelines For Periodic Inspection. On 19 February 2013, Kannad Aviation issued Safety Letter SL18XX502-25-12 Rev02, entitled Kannad 406 ELTs – Guidelines for Periodic Inspection. These documents describe usual operations for periodic checks required by major aviation authorities.

European Aviation Safety Agency

EASA has drafted a safety information bulletin, "Hook and Loop Style Fasteners as Mounting Mechanism for an Emergency Locator Transmitter (ELT)", which echoes FAA Special Airworthiness Information Bulletin (SAIB) HQ-12-32, dated 23 May 2012. After consultation, it will be published at http://ad.easa.europa.eu

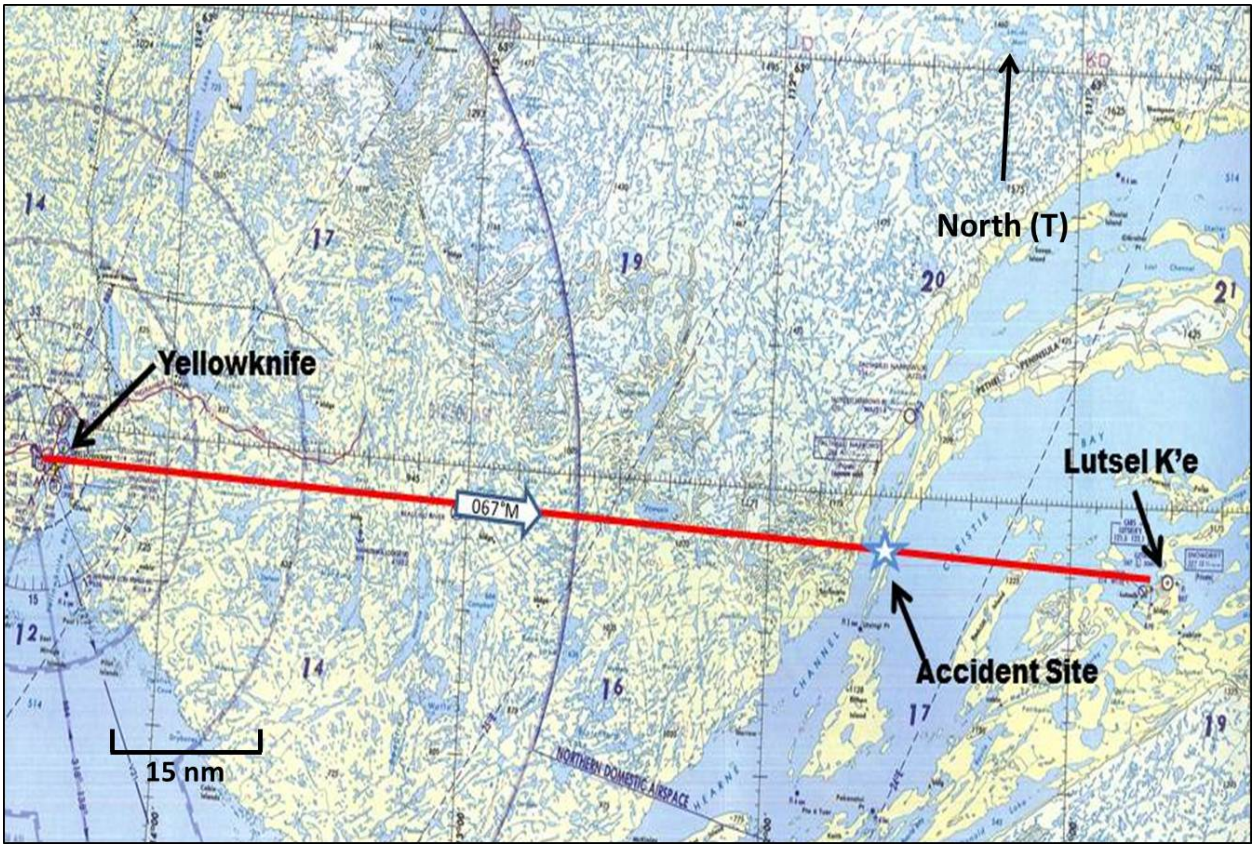
Transport Canada

Transport Canada will produce an article for *Aviation Safety Letter* to highlight the importance of following the manufacturer's installation and retention requirements for ELT installations featuring hook and loop retention systems. Publication is expected in the first quarter of 2013.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 March 2013. It was officially released on 20 March 2013.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

Appendix A - C-GATV Route and Accident Site



Appendix B - Impact Point on Pehtei Peninsula